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Objective

Project leader, director, technical contributor, and/or consultant in the areas of 3D graphics, 2D graphics, digital video, image processing, computer vision, image compression, signal processing, dynamics, numerical analysis.

Summary

Technical Expertise

- Rendering: texture-mapping, bump-mapping, reflection-mapping, environment-mapping, shading, multi-resolution blending, trimmed NURBS, tensor-product and triangular Bezier patches, scan-conversion, ray-tracing, radiosity, interactive control, anti-aliasing. Specializing in algorithms that yield higher quality at higher speed with less memory than traditional algorithms.
- Computer vision: camera calibration, barrel-distortion correction, image registration.
- Applied mathematics: numerical analysis, curve and surface approximations, matrix decompositions, polynomials, quaternions, differential geometry, optimization, projective geometry, solution of linear and nonlinear systems of equations, algorithms for fixed-point arithmetic, signal processing.

Management Experience

- Managed a four-person applied research group of *QuickTimeVR*, encompassing projects encompassing computer vision, rendering, special effects, user interface, authoring and compression. Long-term focus of three years, with quarterly spin-offs of technology and applications.
- Managed a three person team, three-year project to develop the *DaVinci C++* rendering testbed.
- Managed summer interns: develop ray-tracing code, trimmed NURBS tessellation, model development, hardware accelerator support, distributed rendering, image registration, compression, and compositing.
- Managed external research at U.C. Berkeley, Lawrence Berkeley Labs, U. Oregon.
- Technical director of a team of over 20 engineers for the *Pencil Test SIGGRAPH* video.

Programming Skills

- Expert in C, C++. Experience in shell scripts, python, awk, perl, objective-C.

Professional Experience

Google, Inc., Mountain View, California

2007–2009

Member of the Technical Staff

- Developed multi-band blending for use in Street View panoramas and aerial imagery, to produce high-quality, seamless image mosaics.
- Implemented a split-resolution processing pipeline to yield a 2.5X increase in performance, avoiding the need for additional resources in Street View.
- Developed image processing software for new Street View cameras: Bayer plane processing, color space conversion, bilateral filter noise reduction, resampling, sharpening, etc., to increase quality, reduce files sizes and reduce latency.
- Developed software for the Android mobile OS and Chrome browser: cubic Bézier clipping using Newton and bisection algorithms; polygon triangulation using the Fournier-Montuno algorithm.
- Developed mesh simplification by removal of control points in regions of low curvature. Developed optimized rendering of thin-plate spline image warping. Together these reduced redundancy and increased rendering speed by two orders of magnitude, and enhanced interactivity for Q/A-ing new Earth satellite imagery.
- Helped develop satellite image registration using robust RANSAC fitting of corresponding features, used for automatically ingesting new assets into a global GIS image database, radically reducing the amount of manual alignment. Worked with users to identify features that would enhance workflow.

- Performed statistical data analysis and visualization, producing hundreds of web pages semi-automatically, to evaluate the quality of large-scale deployment of new algorithms.

Adobe Systems, Inc., San Jose, California

2006–2007

Senior Engineer/Scientist

- Image processing using fragment shaders in the Graphics Processing Unit (GPU) of a graphics card, for use in After Effects and other products: Gaussian blur, motion blur, radial blur, unsharp mask, color space conversions, linear and radial gradients, fractal noise, etc.

Reality Pixels, Menlo Park, California

2003–2006

Independent Consultant

- Fakespace – Wrote a 3D stereo camera for OpenGL with off-axis non-coplanar projection. Pincushion distortion correction. Calibration of a fisheye lens and head-mounted display.
- A semiconductor manufacturing firm in Silicon Valley – optimized software for inspecting manufacturing defects of semiconductors.
- VRWay, Lugano, Switzerland – Developed a post-production workflow application to convert a master equirectangular panoramic image and hotspot image into multiple resolutions of QuickTime VR and Java-based PTVIEWER files, controlled by an XML job file.
- Mind's Eye View, Cohoes, New York – Evaluation of patent portfolio. Development of correction software for barrel distortion, vignetting, color correction, projection from fisheye to equirectangular images, multi-resolution blending, polar projections, anisotropic spherical convolution. Used in Pictosphere's *Click Away* imaging software and related products.
- QuickTime Stereoscopic Group, London, England – Implementation of a QuickTime effect to drive auto-stereoscopic displays.
- eVox Productions LLC, Long Beach, California – Delivered a seminar on compression and web delivery of panoramas, object movies and linear movies.
- ManyOne Networks, San Mateo, California – Developed an extensive C++ class library for robust and efficient matrix and vector operations.
- Media Machines, San Francisco, California – Developed operations for matrices, quaternions, viewports, culling, and collision for *Flux*, a 3D browser for X3D and VRML, currently running on Microsoft Windows.
- Kinoma, Palo Alto, California – Developed image transformation and compositing software for handheld color PDA's, Macintosh, Windows and Linux.
- Gimlé Limited, Christchurch, New Zealand – Developed memory- and file-based software for 90° rotation and resampling of very high resolution 1 and 2 bit images.

Kinoma, Inc., Palo Alto, California

2003–2006

Senior Software Engineer (half-time)

- Developed cubic panorama viewing software for Palm devices. Developed SVG-compatible 2D graphics rendering software for handheld color PDA's, Macintosh, Windows and Linux. Path rendering includes areas bounded by Bézier curves, elliptical arcs and linear segments with anti-aliasing, and filled with flat colors or gradients. YUV->YUV 4:2:0 & 4:2:2 scaling and Nx90° rotation.

Apple Computer, Inc., Cupertino, California

1986–2003

Senior Research Scientist

- *MrStitch* – Developed an application for creating photomosaics and panoramas.
- *Raw (None) Codec* – Developed a rendering component to composite images, used ubiquitously in QuickTime, with parameters: 3x3 perspective transformation; 9 transfer modes; 11 source and destination pixel formats; 3 quality levels (point, bilinear, bicubic); clip mask.
- *Aarim* – Designed and developed a stream-oriented, anti-aliased image resampler, used in QuickTime, QuickTimeVR, and CoreGraphics (e.g. dock icons).
- *DeFish* – Developed an application for projecting fisheye images to planar and cylindrical.
- *DeJitter* – Developed an application for removing jitter from a sequence of images, especially for producing QuickTime VR object movies.

- *InteractivePStitcher & FishEyeStitcher* – Developed key components of applications for stitching perspective and fisheye images into panoramas.
- *QuickTime VR Authoring Studio* – Developed key components of an application for authoring QuickTime VR panoramas, objects, and scenes; particularly, the stitching technology.
- *LightningVR* – Developed the cubic and cylindrical real-time rendering engines for QuickTime VR.
- *FlysEye* – Developed a library of reusable functions for mathematics, optimization, registration, file I/O, rendering, image processing, geometry, user interface.
- *MakeCubic* – Developed an application to take an equirectangular spherical image, six faces of a cube, or a cubic QuickTime VR movie, and convert it into a cubic QuickTime VR movie.
- *VRMakePano.c* – Developed a library-quality module to create QuickTime VR movies.
- *QTVR Flattenner* – Developed key components of an extension for optimizing QuickTime VR web delivery.
- *Explode Effect* – Developed the algorithm used for the explode effect in QuickTime.
- *Altivec* – Contributing designer of the instruction set of vector operations for the PowerPC.
- *Scenery* – Developed an application to interactively display 3D scenes, used internally at Apple.
- *MonaLisa* – Developed a 3D scan-converter, featuring texture-mapping and programmable shaders (e.g. Gouraud, Phong, Blinn, Fresnel, anisotropic). Transportable code (Macintosh & IRIS) uses GL hardware acceleration when available.
- *MLEO* – Developed a high-level, object-oriented rendering library, featuring animation, trimmed NURBS, tensor product Bezier patches, triangular Bezier patches, polyhedra, triangle strips, cones, cylinders, spheres, cameras (perspective, orthographic, oblique, cylindrical), textures, shaders, transformations, extensibility.
- *EO* – Developed a forward- and backwards compatible, extensible, object-oriented file format with persistent internal and external references and custom data types. Specialized it for representing 3D scenes (*EO3D*), and presented it to the ANSI graphics committee.
- *Bento* – Contributing architect for a generalized version of *EO*.
- *QuickDraw3D* – Contributing architect and developer of a 3D system, featuring extensible geometric primitives, extensible renderers, extensible shaders, user interface, and file format.
- *VRML* – Contributor to the international working group for the Virtual Reality Modeling Language Compressed Binary Format, eventually incorporated into MPEG-4 BIFS.
- *DaVinci* – Manager, prime architect and contributor for a team of three to develop a 3D rendering testbed, composed of reusable C++ modules. Features include: Z-buffer, radiosity, ray-tracing, texture-, reflection-, and bump-mapping, shade trees, anti-aliasing, polygons, bicubic patches, quadrics, generation of differential geometric information for shaders; co-developed on Macintosh and Iris.
- *MacGL* – Contributor to a 3D graphics library with GL functionality on the Macintosh.
- *TrueType* – Initial investigations and strategy for implementation of outline-based fonts.
- *NuGraf* – Contributor to a 2D graphics library (progenitor to QuickDrawGX and eventually CoreGraphics) with both fixed- and floating-point interface to draw polygons, B-splines, ellipses, with 3x2 matrix transformations.
- *Pencil Test* – Technical director and contributor for the first Macintosh-synthesized 3D video to be accepted into the SIGGRAPH Electronic Theatre. Managed over 20 engineers to develop the rendering software, with anti-aliasing, texture-mapping and Phong shading, that ran on a network of Macintosh II's with 4-8 Mb of RAM, and produced CCIR-601 digital video.
- *The Audition* – Contributor to the renderer used for this SIGGRAPH Electronic Theatre video.
- *MacHeadGuy* – Developer of the chroma-keying Cray software used to produce this video.
- *Hardware Acceleration* – Helped develop a strategy for graphics accelerators.

CIMLINC (CADLINC), Inc., Menlo Park, California

1982–1986

Senior Scientist/Engineer

- Designed a graphical accelerator for anti-aliased monochrome and color 2D graphics. Wrote assembler, diagnostic language, and microcode. Features RasterOp compositing, anti-aliased lines, polygons.
- Developed image compositing and transformation code.
- Developed 3D transformation code for offline robotic simulation.
- One of the authors of *compress*, a UNIX utility for LZW file compression.
- Wrote an assembler for using PROMs for random logic.

- Developed a library of arbitrary-precision rational arithmetic for a robust solid modeler.
- Developed a color space to maximize the number of anti-aliased line colors with a limited palette.

Compression Labs, Inc., San Jose, California

1982

Software Engineer

- Wrote menu-based diagnostics for a video teleconferencing system.

Ampex Corporation, Redwood City, California

1978–1982

Hardware/Software Engineer

- Wrote separable algorithms for image resizing, rotation and other video special effects.
- Designed a video digitizer board for AVA, the first commercial video paint system.
- Wrote software to convert scanned-in images to polygons with subpixel resolution. Created a polygon font library. Wrote scan-converter for anti-aliased fonts in AVA.
- Wrote an assembler for a programmable video display generator.
- Wrote an interpreter for hardware diagnostics.
- Wrote a fixed-point trigonometry package using CORDIC iterations.

Papers

- Incremental Computation of the Gaussian, *GPU Gems 3*, Addison-Wesley, 2008, pp. 877-889.
- Scanline-Order Image Warping using Error-Controlled Adaptive Piecewise Polynomial Approximation, Apple Technical Report, Jan. 2002.
- Registration, Calibration and Blending in Creating High Quality Panoramas, with Yalin Xiong, *Fourth IEEE Workshop on Applications of Computer Vision*, Princeton, New Jersey, October 19-21, 1998, pp. 69-74.
- Creating Image-Based VR Using a Self-Calibrating Fisheye Lens, with Yalin Xiong, *Computer Vision and Pattern Recognition 1997 Conference*.
- Computing the inverse square root, *Graphics Gems V*, Academic Press, 1995.
- Fixed point square root, *Graphics Gems V*, Academic Press, 1995.
- Circular arc subdivision, *Graphics Gems V*, Academic Press, 1995.
- An Object-Oriented Testbed for Global Illumination, *Object-Oriented Programming for Graphics*, Springer-Verlag, 1995, pp.156-166 (presented in June 1991).
- The differential geometry of texture mapping and shading, Apple Technical Report, May 1992.
- The use of coordinate frames in computer graphics, *Graphics Gems*, Academic Press, 1990.
- Filters for common resampling tasks, *Graphics Gems*, Academic Press, 1990.
- Properties of surface normal transformations, *Graphics Gems*, Academic Press, 1990.
- Fixed-point trigonometry with CORDIC iterations, *Graphics Gems*, Academic Press, 1990.
- The differential geometry of texture mapping, Apple Technical Report no. 10, May 1988.
- Anti-aliasing in topological color spaces, *SIGGRAPH 1986*.
- Anti-aliasing through the use of coordinate transformations, *Transactions on Graphics*, vol. 1, no. 3, July 1982.

Patents

- Aligning rectilinear images in 3D through projective registration and calibration #6,434,265 (2002).
- Method and system for simulating motion in a computer graphics application using image registration and view interpolation, #5,926,190 (1999).
- Method and system for the extensibility of objects, #5,819,283 (1998).
- Method for parallel interpolation of images, #5,625,374 (1997).
- Method and system for reordering bytes in a data stream, #5,594,919 (1997), #5,524,256 (1996)
- Apparatus and method for forming a composite image pixel through pixel blending, #5,444,835 (1995).
- YIQ Computer graphics system, #4,564,915 (1986).

Education

- Master of Engineering, Electrical Engineering and Computer Science, University of California, Berkeley.
Thesis: APOGEE, A Processor Organized for Graphics Encoding and Editing. Design of a parallel processor for telegraphics, i.e. graphical conversations over a telephone line.
- Bachelor of Science, Electrical Engineering, University of Illinois, Champaign-Urbana.

Associations

- Association for Computing Machinery (ACM), Special Interest Group in Graphics (ACM SIGGRAPH), Institute of Electrical and Electronics Engineers (IEEE), IEEE Computer Society, Eurographics, Society for Industrial and Applied Mathematics (SIAM).
- Silicon Valley ACM SIGGRAPH chapter vice chair ('06-present), chair ('01-'06), secretary ('00-'01), vice chair ('96-'00).

URLs from other sites about my work

- http://developer.apple.com/samplecode/VRMakePano_Library/index.html (VRMakePano.c sample code).
- <http://www.worldserver.com/turk/opensource/index.html> (my open source).